UV-Visible Missions for NASA Long-Duration Balloons (LDBs)

by

Charles L. Joseph, Assoc. Research Professor

Physics & Astronomy Dept., Rutgers U.

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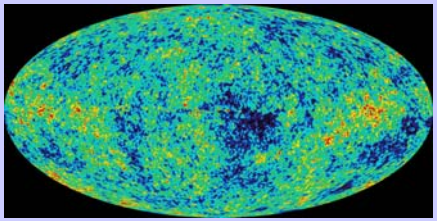
Motivation

A consistent picture of the evolution of the Universe from the Big Bang to the present is emerging. Some data, however, suggest galaxies may not fit this model!

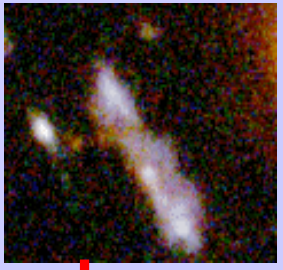
---The Big Bang --



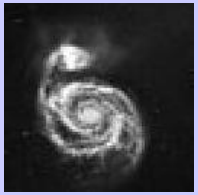
(15 Billion Yrs Ago. z > 100)

The Unobserved Realm
To Be Explored by JWST
First Star Formation
First Galaxy Structures

From the Early Universe
(11 Billion Yrs Ago; z ~ 1.5)
Galaxies were less well organized



Galaxy Evolution
To be observed by HAWK



Payload

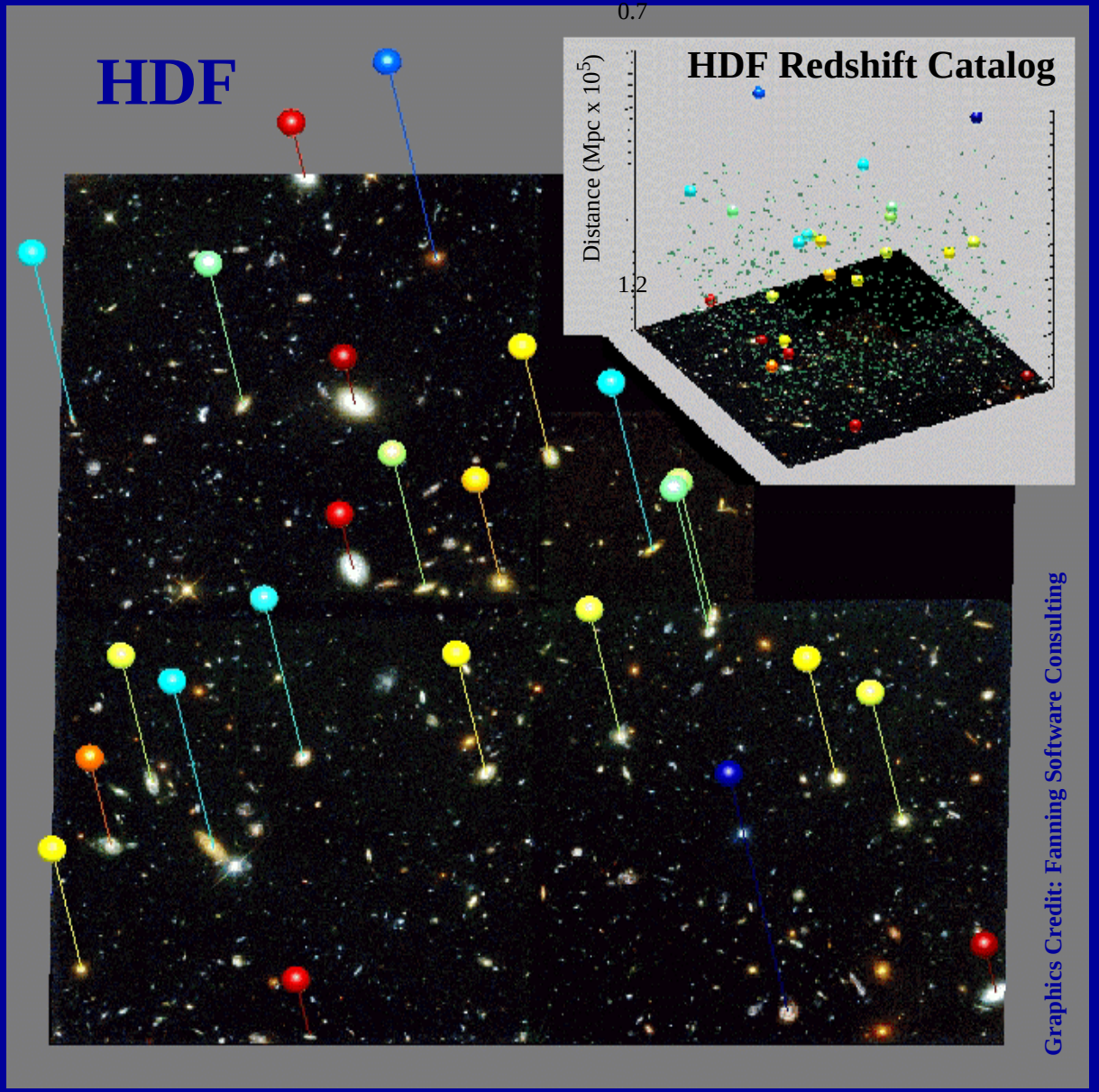
Merging Galaxies

HAWK Balloon Mission Objective:

Study all motions in A 10 Mpc^3 Volume!

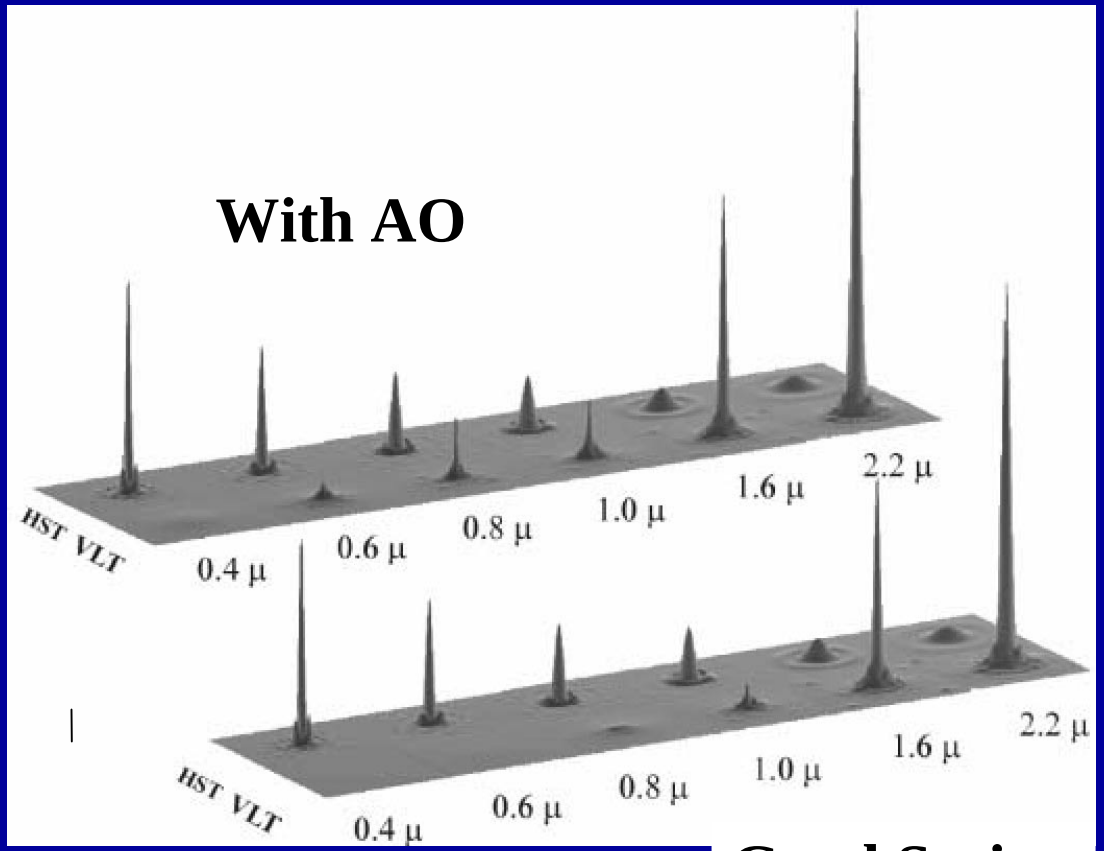
GSS-104-4024 (z=0.81). HST/NICMOS+WFPC2
A high-redshift galaxy showing the satellite dwarfs predicted by models. (Data taken by CoI Vogt.)

Most distant galaxies should have dwarf satellites



HAWK LDB Balloon -- Can't do it with Large Ground-based Telescopes with AO

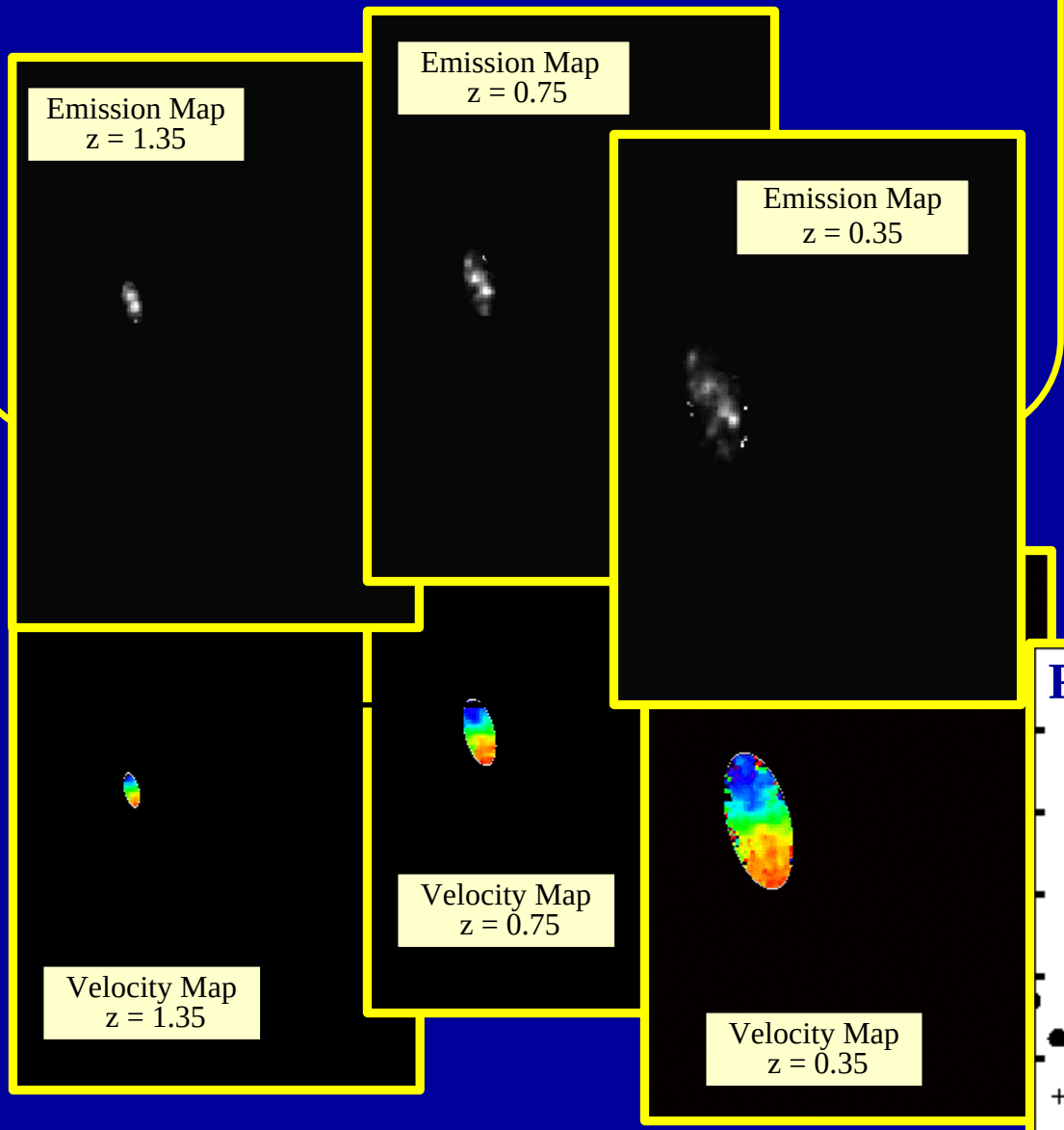
HDF North



Ground-IR have Bad Thermal Backgrounds!

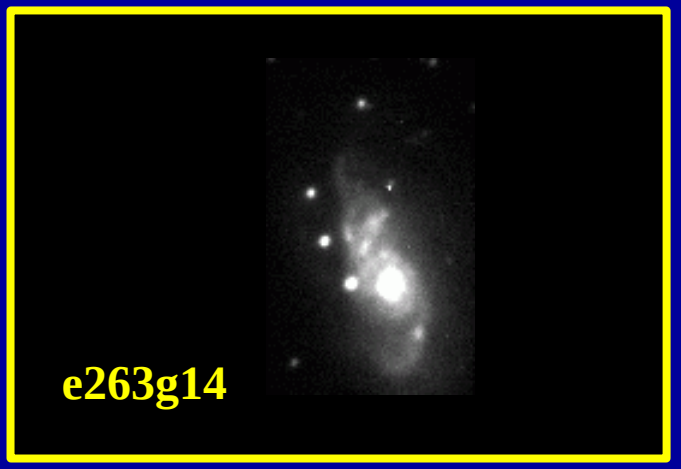
Good Seeing Without AO

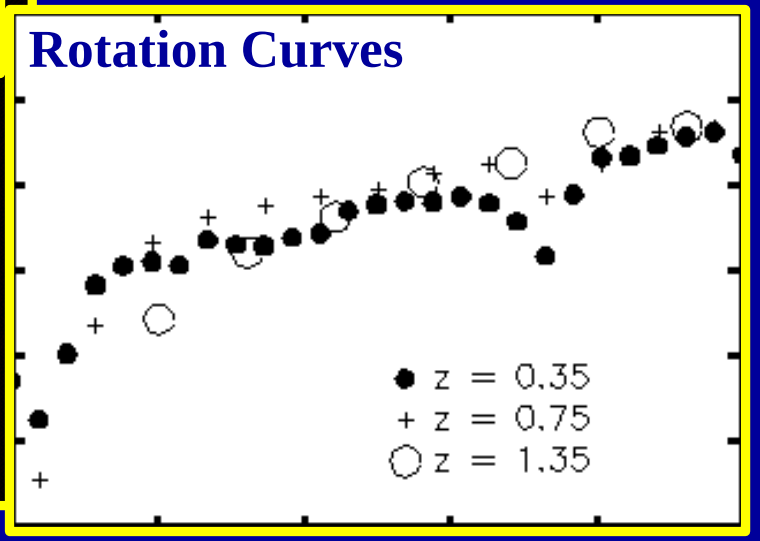
Observing Galaxies as a Function of Z, Distance (i.e. Age of Universe)



HAWK Balloon Mission Objective:

Measure luminous and dark matter in galaxies





LDB vs. Mauna Kea Altitudes

Image Quality Comparison

Alt.	Aperture	r_0 (m)	FWHM(")	θ_0 (")	τ_0 (sec)
4 km	CFHT 3.8m	0.18	0.7	3	0.0036
35 km	2.4 m	~250	0.048	~600	~5
35km	10 m	~250	0.012	~600	~5

Atmospheric Parameters Comparison

h (km)	P (mbars)	T (K)	ρ (gm m^{-3})	H_2O Vapor (gm m^{-3})
4	680	253	937	0.68
35	4.7	222	7.4	0.00011

Data from Ford *et al.*

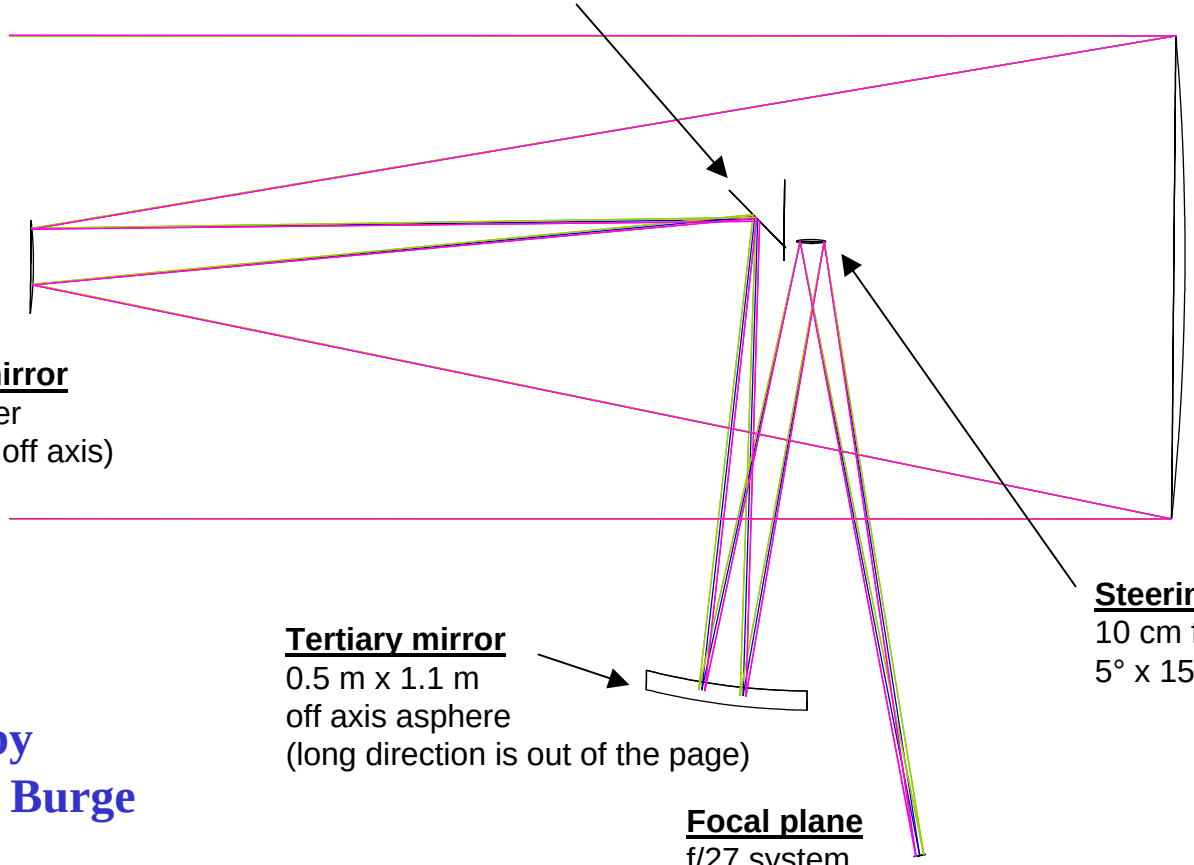
Telescope optical design

System is fully steerable over 0.5° x 1.5° using only tip/tilt of a 10 cm flat mirror

0.5° x 1.5° field of regard
2.2 arcsec IFOV

Pickoff mirror
30 x 64 cm flat
near intermediate focus

Primary mirror
1.8 m diameter
f/2.7 (from MMT)



Secondary mirror
35 cm diameter
(Used slightly off axis)

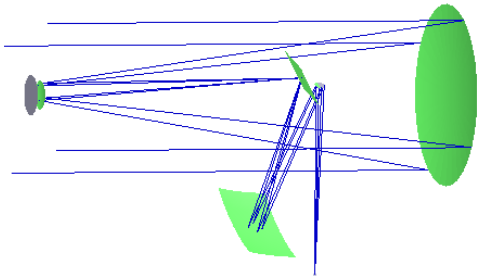
Steering mirror
10 cm flat
5° x 15° range of motion

Tertiary mirror
0.5 m x 1.1 m
off axis asphere
(long direction is out of the page)

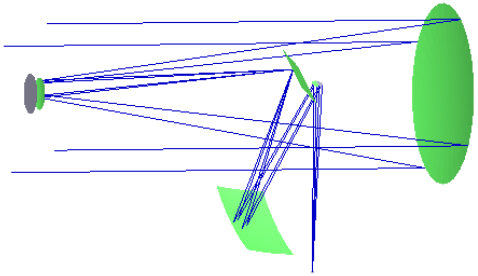
Focal plane
f/27 system
4.2 arcsec/mm plate scale
(2k x 2k x 16 µm CCD shown here)

Design by
CoI Jim Burge

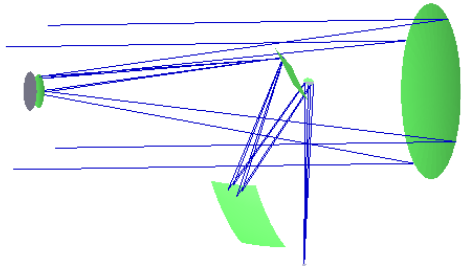
Anamorphic field of regard



On-axis
Steering mirror in middle of range
Beam footprint in middle of pickoff, tertiary mirrors



System looking down 0.25°
Steering mirror tilted 2.5°
Beam footprint shifted on pickoff, tertiary mirrors



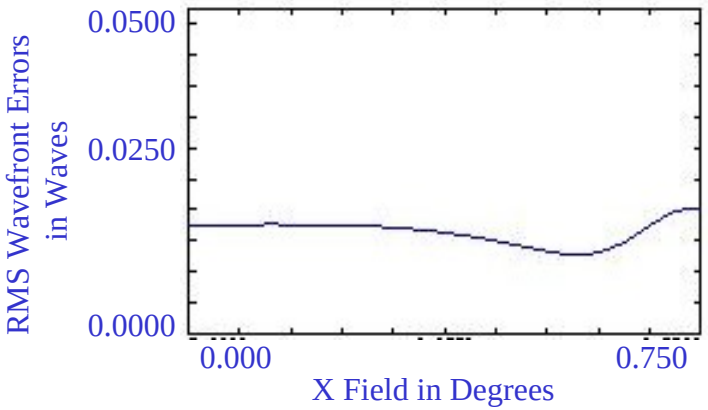
System looking left 0.75°
Steering mirror tilted 7.5°
Beam footprint shifted on pickoff, tertiary mirrors

Giant field requires large tertiary mirror

Excellent performance

Nominally designed so that rms wavefront error RMSWE is limited to 20 nm.

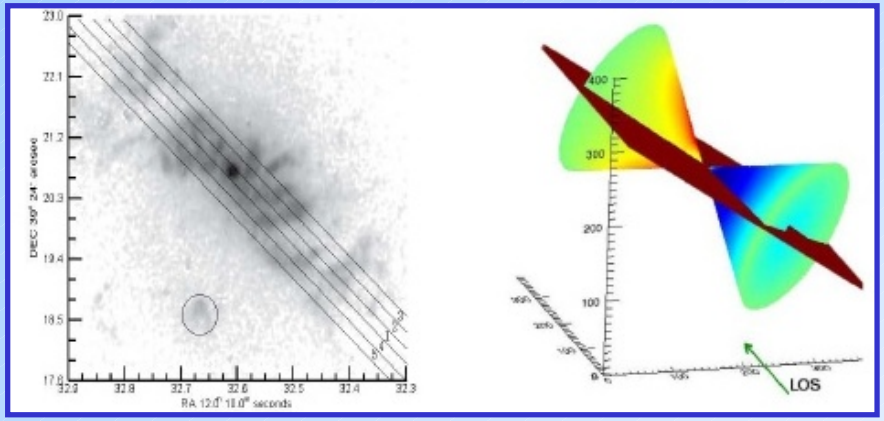
Low imaging distortion (4% max at corners of field)



KITE

Kinematical Imaging Trailblazer Experiment

Swallow-tail Kite by D.A. Rintoul, USGS

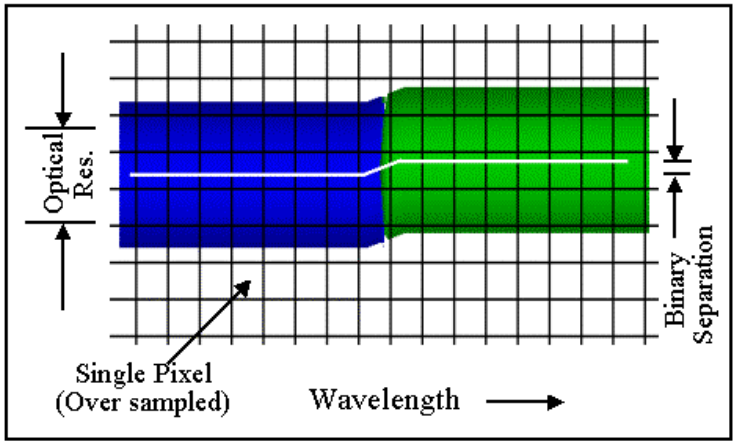


Fabry-Perot observations of NLR gas of AGNs

Telescope: 0.75 m telescope

Near-UV detector: 3x sensitivity

Stellar Evolution of Cepheids and other Binaries using the Cross-Dispersion Imaging Technique. (3 mas Resolution)

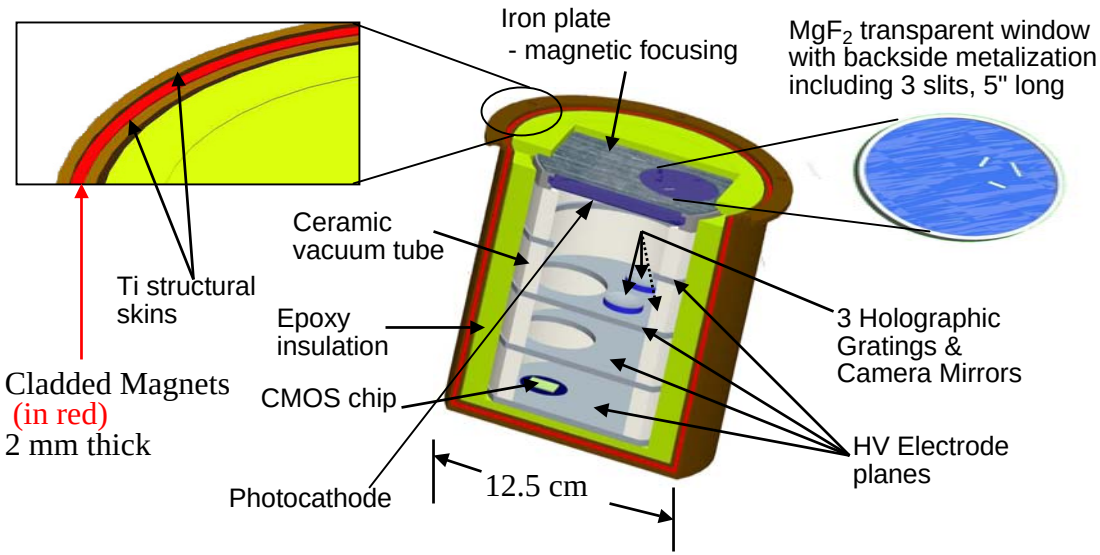


Rutgers The State University of New Jersey

KITE

Kinematical
Imaging
Trailblazer
Experiment

Innovative Detector Designs with increase QE and important component of ACS System



Layered Attitude Control System (ACS)